# PATENT SPECIFICATION

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**749,248**

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COMPLETE SPECIFICATION

## Improvements in or relating to Epicyclic Change-Speed Gearing

We, STURMEY-ARCHER GEARS LIMITED, a British Company, of 177, Lenton Boulevard, Nottingham, in the County of Nottingham, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to epicyclic change-speed gears for pedal bicycles of the type comprising sun, planet, planet carrier and annulus members with alternative pawl and ratchet couplings respectively a first ratchet coupling between the annulus and an output member and a second ratchet coupling between the planet carrier and the output member, with a slidable selective coupling member adapted to couple an input member with either the planet carrier or the annulus in combination with means for rendering the first ratchet coupling inoperative for one position of the slidable selective coupling member while providing coupling between the input member and the annulus. Such hubs are well known. The epicyclic gear train may be of the simple type or may comprise stepped planet pinions which may be used with alternative sun wheels or may comprise two or more coupled gear trains. The feature common to these hubs is the alternative output couplings with provision for rendering the annulus ratchet coupling inoperative as above described.

For use on pedal bicycles it is desirable that the diameter of the hub shell should be kept as small as possible on the score of appearance and that the hub should be kept as light as possible consistent with the strength necessary to carry the loads imposed. The size and weight of such hubs is governed in the main by strength considerations and not by the diameter of the gear train as such. The input member must be of a size adequate to carry the input torque and this size in turn governs the size of the surrounding member which carries the output coupling pawls normal to such hubs.

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It is one object of this invention to provide other forms of improved ratchet output coupling mechanism for hubs of this type which provides adequate strength in a smaller space than hitherto, with a consequent possible reduction in the size and weight of the hub.

It is a further object to provide a simpler method of rendering such ratchet coupling inoperative for the known purpose of using the other output coupling for any selective ratio thereby made available and which method avoids the need for phasing of the selector member and the output coupling.

According to the invention an epicyclic change-speed gear for pedal bicycles comprising sun, planet, planet carrier and annulus members with alternative-output couplings respectively a first output coupling between the annulus and an output member and a second output coupling between the planet carrier and the output member with a slidable selective coupling member adapted to couple an input member with either the planet carrier or the annulus in combination with means for rendering the first output coupling inoperative for one position of the slidable selective coupling member while providing coupling between the input member and the annulus said first output coupling consisting of a single slidable coupling ring separate from said selective coupling member and having separate sets of coupling formations directly complementary to coupling formations on the annulus and output members, one such set of coupling formations providing ratchet coupling, the said ring being slidable to engage or disengage one of the sets of coupling formations, characterised in that one set of coupling formations comprises complementary end formations on the adjacent end faces of the annulus and ring.

A change-speed gear according to the invention may be further characterised in that the said complementary end formations constitute the engageable and disengageable set of coupling formations; or in that the said

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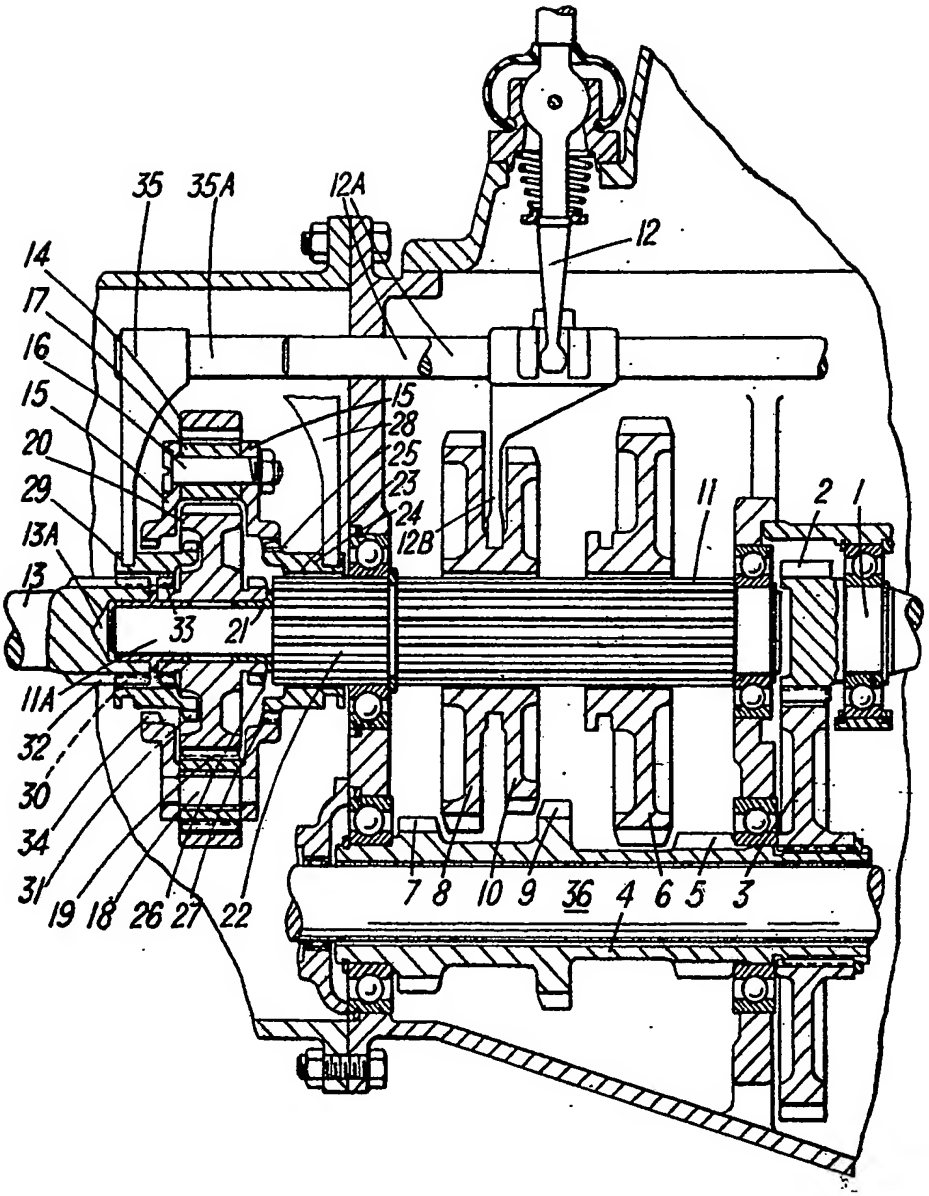
This drawing is a reproduction of the Original on a reduced scale.



disengageable formations are shaped as ratchet teeth to provide the ratchet coupling; or in that the said single slidable coupling ring has ratchet teeth formations on one end face complementary to ratchet teeth formations on the adjacent end of the annulus and dog-coupling formations on its outer periphery slidably complementary to splines in the output member; or in that the single slidable coupling ring carries outwardly directed pawls complementary to ratchet teeth on the output member and axially disengageable dog-clutch formations on its end face complementary to dog-clutch formations on the adjacent end of the annulus; or in that the complementary end formations are permanently engaged and that the other formations of the set comprises pawl-and-ratchet couplings which are engageable and disengageable by sliding movement of the ring.

In the drawing filed with Application No. 28917/52.

Fig. 1 shows a longitudinal section of a three-speed hub according to one form of the invention, some of the parts being shown in one gear position above the centre line and in another gear position below the centre line.

Fig. 2 shows a sectional end view on the line AA of Fig. 1.

Fig. 3 shows a detail of the ratchet teeth on the annulus and right-hand ratchet ring.

In the drawing filed with Application No. 14118/53

Fig. 4 is a longitudinal section on line 4—4 of Fig. 5 of a three-speed hub made in accordance with the present invention some of the parts being shown in one gear position above the centre line and in another gear position below the centre line;

Fig. 5 is a section on line 5—5 of Fig. 4;

Fig. 6 is a section on line 6—6 of Fig. 4;

Fig. 7 is a fragmentary detail view of part of Fig. 4;

Fig. 8 is a longitudinal section similar to Fig. 4 on line 8—8 of Fig. 9 showing only the right-hand end of a further modified construction;

Fig. 9 is a cross section on line 9—9 of Fig. 8;

Fig. 10 is a fragmentary view of part of Fig. 8.

Where the parts are the same or substantially the same as described for Figs. 1 to 3, they are given the same reference characters.

As shown in Figures 1 to 3 a change-speed gear hub according to one form of the invention comprises a axle 1 on which is cut a sun pinion 1*a*. Meshing with this sun pinion are planet pinions 2 which are carried on pins 3*a* of the planet carrier 3. Said planet carrier is mounted on the axle 1 and retained against the sun pinion by a spring ring 4. Pillars 3*b* on the planet carrier 3 project beyond the pins 3*a* so as to form dog members, which are grooved on their outer periphery to hold a spring ring 2*a* for holding the pinions 2 on their pins. The gear train is completed by the annulus 5 meshing with the planet pinions 2. An extension of the gear ring 5*a* is provided internally with splines 5*b* and on its end with ratchet teeth 5*c*. The planet carrier 3 is also provided with an extension 3*c* in which are cut slots 3*d*. A ring 6 is mounted on the extension 3*c* so as to slide axially thereon by the influence of the spring 7 and internal dogs 6*a* constrain this ring 6 to rotate with the planet carrier 3. Ratchet teeth 6*b* are formed on one face of the ring and these engage with co-acting teeth 8*a* on the bearing member 8.

The bearing member 8 is screwed into the hub shell 9 at 9*a* and rotates on balls 10 running on a further bearing member 11 which is screwed on the axle 1. Into the other end of the hub shell at 9*b* is screwed a further bearing member 12 running on balls 13 which run on a race formed on the input member 14. The input member 14 runs on further balls 15 running on a further bearing member 16 which is screwed on the axle 1. Within the member 12 is a ring 17 free to rotate or move axially on the input member 14 and provided with dogs 17*a* which engage with splines 12*a* in the member 12 so that the ring 17 is constrained to rotate with the member 12. The ring 17 is further provided with ratchet teeth 17*b* which coact with the teeth 5*c* on the annulus 5 under the influence of the spring 18. Mounted on the axle 1 is a sleeve 19 provided with a key 20 free to move axially in the axle slot 1*b*. A rod 21 is screwed into the axle key and lies in a hole 1*c* of the axle 1. Mounted on the sleeve 19 is a clutch member 22 and a washer 23 and spring 24 normally urges the clutch member 22 to the left unless the control rod 21 is moved by external means. The clutch member 22 has projecting limbs 22*a* engaging with slots 14*a* in input member 14 so that the cluteh member 22 is constrained to rotate with the input member 14 but is able to slide axially therein. Mounted on the input member 14 is a sprocket 25 in splines 14*b* secured by washers 26 and a spring ring 27.

The operation of the gear is as follows:

Normally the spring 24 urges the clutch member to the left so as to couple the input member 14 to the planet carrier 3 by engagement of the limbs 22*a* with the dog members 3*b*. Since in an epicyclic gear of this type the annulus is always the fastest rotating member the drive is transmitted through the gears to the annulus 5 and hence via the teeth 5*c* to the ring teeth 17*b*, the dogs 17*a* and splines 12*a* to the hub shell 9. Since the bearing member 8 is rotating faster than the planet carrier 3 the ratchet teeth 8*a* over-ride the ratchet teeth 6*b* on the ring 6 which rotates with the carrier 3. This gives an increase gear.

When the clutch member 22 is moved to

the right by pulling the control rod 21 until the clutch member 22 engages the splines 5*b* on the annulus as shown below the centre line in Figure 1 a direct drive is obtained since the gear train is then only idling. The left hand ratchet teeth 8*a* and 6*b* over-run as described for the increase gear.

Further movement of the clutch member 22 to the right causes the right hand edges of the limbs 22*a* to move the ratchet ring 17 to the right so as to disengage the ratchet teeth 17*b* and 5*c* but still leaves the input member coupled to the annulus splines at 5*b* via the limbs 22*a*. The drive now enters the annulus and is transferred via the gears to the planet carrier and thence via the ratchet teeth 6*b* and 8*a* to the bearing member 8 and the hub shell 9. This gives a reduction gear. This gear position is shown above the centre line in Figure 1.

In the previously known construction it has been necessary to phase or position the pawls with the splines so that the limbs of the selector member can engage with and tip the pawl out of engagement with the splines. In the construction above described such phasing or positioning is not necessary and this represents an important simplification of construction.

As shown in Figs. 4 to 7, the change speed gear hub has many parts which are the same as shown in Figs. 1 to 3 and are given the same reference characters. The gear comprises a fixed axle 1 on which is cut a sun pinion 1*a*. Meshing with this sun pinion are planet pinions 2 which are carried on pins 3*a* of the planet carrier 3. Said planet carrier is rotatably mounted on a rebated flange 1*d*. The pins 3*a* are extended through the pinions 2 so as to form driving dog members and a ring 2*b* is mounted on the extended pins so as to position the planet pinions 2. The gear train is completed by the annulus 5. An extension of the annulus 5 is slotted to form inwardly directed dogs 5*d* and end dogs 5*e*. The planet carrier 3 is also provided with an extension 3*e* carrying pawls 3*f* which engage with ratchet teeth 8*a* formed in an end cap 8 which is screwed at 9*a* into the hub shell 9 which rotates on balls 10 on a bearing member 11 which is screwed to the axle 1 into the other end of the hub shell 9. At 9*b* is screwed a further end cap 12 mounted on ball bearings 13 which in turn run on an input member 14 which again is mounted on further balls 15 running on a bearing member 16 screwed on the axle 1. Within the end cap 12 and slidably and rotatably mounted on the input member 14 is a ring 17*c* carrying pawls 17*d* located in pockets 17*e*. The ring 17*c* is urged in one direction by a spring 18 engaging a washer 18*a* which washer also serves to retain the pawls 17*d* in their pockets. These pawls are adapted to engage ratchet teeth 12*a* formed on the end cap 12. Mounted on the axle 1 is a sleeve 19 provided with a key 20 free to move axially in a slot 1*b*; a rod 21 is screwed into the axle key 20 and is located in an axial hole 1*c* in the axle 1. Mounted on the sleeve 19 is a clutch member 22 behind which is a washer 23 and spring 24 normally urging the clutch member 22 to the left of Fig. 4 against any restraint force applied through the rod 21. The clutch member 22 has peripheral dogs 22*a* projected through apertures between finger-like extensions 14*a* of the input member 14 so that such clutch member is constrained to rotate therewith but is able to slide axially. The dogs 22*a* are adapted peripherally to engage the internally formed dogs 5*d*. Mounted on the input member 14 is a chain sprocket 25 located on splines 14*b* and secured by washers 26 and a spring ring 27. The ring 17*c* is formed with an annular recess providing an end face 17*f* adapted to be engaged by the end face of the dogs 22*a* and such ring 17*c* is formed with end dogs 17*g*. The operation of the gear is as follows:

The spring 24 urges the clutch member 22 to the left of Fig. 4 so as to couple the input member 14 to the planet carrier 3 by engagement of the dogs 22*a* with the pinion pins 3*a* as shown dotted in the lower half of Fig. 4. At the same time the spring 18 urges the ring 17 so that the end dogs 17*g* are fully engaged with the end dogs 5*e*, such position being shown in the lower half of Fig. 4. Since in an epicyclic gear of this type the annulus is always the fastest rotating member, the drive, transmitted through the gears to the annulus 5 passes via the end dogs 5*e* and 17*g* to the ring 17 and then through the pawls 17*d* to the ratchet teeth 12*a* and so to the hub shell 9. Since the end cap 8 is rotating faster than the carrier 3 the ratchet teeth 8*a* overrun the pawls 3*f*. This gives an increase gear.

When the clutch member 22 is moved to the right by the rod 21 until the lugs 22*a* engage with the inner dogs 5*d* of the annulus 5 as shown below the centre line of Fig. 4 a direct drive is obtained since the gear train is only idling, the drive passing direct through the coupling 22*a* and 5*d* to the annulus and through the pawls 17*d* and ratchet teeth 12*a* to the end cap 12.

Further movement of the clutch member 22 to the right causes the right hand faces of the peripheral dogs 22*a* engaging the end face 17*f* to move the ring 17*c* to the right so as to disengage the end dogs 17*g* and 5*e* (see Fig. 7) but still leaves the coupling between 22*a* and 5*d*. The drive still entering the annulus through such coupling is transferred via the gears to the planet carrier 3 and thence via the pawls 3*f* and ratchet teeth 8*a* to the end cap 8 and hub shell 9. This gives a reduction gear and the positions of the parts are as shown above the centre line in Fig. 4. The pawls 17*d* remain engaged with the ratchet teeth 12*a* and the ring 17*c* being otherwise free can therefore rotate with the end cap 12.

A further modification of the invention is as shown in Figs. 8 to 10. The arrangement of

the parts is generally as shown in Figs. 4 to 7 but with the following variations. A pawl ring 28 is provided replacing the ring 17*c* and having lugs 28*a* (see Fig. 9) engaging with slots between dog-like extensions 29*a* in the annulus 29 so that it always rotates with the annulus but is capable of moving axially therein. In the lugs 28*a* are pawl housings 28*b* carrying pawls 30 engageable with short ratchet teeth 31*a* in the end cap 31. The gear movements are as before, direct drive being shown below the centre line and the reduction gear above the centre line. It will be seen that the clutch member has now moved the ring 28 so as to disengage the pawls 30 axially from the teeth 31*a* and so break the driving connection between the annulus 29 and the output member 31. The left-hand position of the ring 28 under the action of the spring 18 is determined by a shoulder 29*b*. Such position is shown in the lower half of Fig. 8.

In a modified construction of the gear, the output ratchet coupling illustrated at the left hand end of Figure 1 and consisting of the parts 3, 6 and 8 could be replaced by the normal radial pawl and ratchet coupling since there is usually ample space at this end for such type of ratchet coupling.

What we claim is:—

1. An epicyclic change-speed gear for pedal bicycles comprising sun, planet, planet carrier and annulus members with alternative output couplings respectively a first output coupling between the annulus and an output member and a second output coupling between the planet carrier and the output member with a slidable selective coupling member adapted to couple an input member with either the planet carrier or the annulus in combination with means for rendering the first output coupling inoperative for one position of the slidable selective coupling member while providing coupling between the input member and the annulus, said first output coupling consisting of a single slidable coupling ring separate from the said selective coupling member and having separate sets of coupling formations directly complementary to coupling formations on the annulus and output members, one such set of coupling formations providing ratchet coupling, the said ring being slidable to engage or disengage one of the sets of coupling formations, characterised in that one set of coupling formations comprises complementary end formations on the adjacent end faces of the annulus and ring.

2. An epicyclic change-speed gear according to claim 1 further characterised in that the said complementary end formations constitute the engageable and disengageable set of coupling formations.

3. An epicyclic change-speed gear according to claim 2, further characterised in that the said disengageable formations are shaped as ratchet teeth to provide the ratchet coupling.

4. An epicyclic change-speed gear according to claim 1 further characterised in that the said single slidable coupling ring has ratchet teeth formations on one end face complementary to ratchet teeth formations on the adjacent end of the annulus, and dog-coupling formations on its outer periphery slidably complementary to splines in the output member.

5. An epicyclic change-speed gear according to claims 1 or 2, further characterised in that the single slidable coupling ring carries outwardly directed pawls complementary to ratchet teeth on the output member and axially disengageable dog-clutch formations on its end face complementary to dog-clutch formations on the adjacent end of the annulus.

6. An epicyclic change-speed gear according to Claim 1 further characterised in that the complementary end formations are permanently engaged and that the other formations of the set comprises pawl-and-ratchet couplings which are engageable and disengageable by sliding movement of the ring.

7. An epicyclic change-speed gear constructed, arranged and adapted to operate substantially as herein described with reference to and as illustrated in Figs. 1 to 3 of the drawings filed with Application No. 28917/52.

8. An epicyclic change-speed gear constructed, arranged and adapted to operate substantially as herein described with reference to and as illustrated in Figs. 4 to 7 of the drawings filed with Application No. 14118/53.

9. An epicyclic change-speed gear constructed, arranged and adapted to operate substantially as herein described with reference to and as illustrated in Figs. 8 to 10 of the drawing filed with Application No. 14118/53.

For the Applicants:
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## PROVISIONAL SPECIFICATION
No. 28917 A.D. 1952

# Improvements in or relating to Epicyclic Change-Speed Gearing

We, STURMEY-ARCHER GEARS LIMITED, a British Company, of 177, Lenton Boulevard, Nottingham, do hereby declare this invention to be described in the following statement:—

This invention relates to epicyclic variable speed gears for pedal bicycles of the type comprising sun, planet, planet carrier and annulus members with alternative pawl and ratchet

couplings between planet carrier and output member and between annulus and output member with selective coupling between an input member and either the planet carrier or annulus, with means for rendering the ratchet coupling between the annulus and output member inoperative for one position of the selective coupling between the input member and the annulus. Such hubs are well known. The epicyclic gear train may be of the simple type or may comprise stepped planet pinions which may be used with alternative sun wheels or may comprise two coupled gear trains. The feature common to these hubs is the alternative output couplings with provision for rendering the annulus ratchet coupling inoperative as above described.

For use on pedal bicycles it is desirable that the diameter of the hub shell should be kept as small as possible on the score of appearance and that the hub should be kept as light as possible consistent with the strength necessary to carry the loads imposed. The size and weight of such hubs is governed in the main by strength considerations and not by the diameter of the gear train as such. The input member must be of a size adequate to carry the input torque and this size in turn governs the size of the surrounding member which carries the output coupling pawls normal to such hubs.

It is one object of this invention to provide an improved ratchet output coupling mechanism for hubs of this type which provides adequate strength in a smaller space than hitherto with a consequent possible reduction in the size and weight of the hub.

It is a further object to provide a simpler method of rendering such ratchet coupling inoperative for the purpose set forth and which avoids the need for phasing of the selector member and the output coupling.

According to the invention an epicyclic variable speed gear of the type described for the rear wheel hub of a bicycle is characterised in that the disengageable ratchet coupling comprises face teeth formed on the annulus, a ring having complementary face teeth means urging the ring into coupling engagement with the annulus and means coupling said ring slidably but so as to rotate with an output member.

A variable gear hub according to the invention is further characterised in that the means for rendering the annulus to output ratchet coupling inoperative is for the selector means to withdraw the annulus ratchet ring out of engagement with the co-acting teeth on the annulus when in one position of its engagement with the annulus.

Referring to the attached drawings:—

Fig. 1 shows a longitudinal section of a three-speed hub according to one form of the invention, some of the parts being shown in one gear position above the centre line and in another gear position below the centre line.

Fig. 2 shows a sectional end view on the line AA of Fig. 1.

Fig. 3 shows a detail of the ratchet teeth on the annulus and right hand ratchet ring.

As shown in Figures 1 to 3 a variable gear hub according to one form of the invention comprises a spindle 1 on which is cut a sun pinion 1*a*. Meshing with this sun pinion are planet pinions 2 which are carried on pins 3*a* of the planet carrier 3. Said planet carrier is mounted on the axle and retained against the sun pinion by a spring ring 4. Pillars 3*b* on the planet carrier 3 project beyond the pins 3*a* so as to form dog members, which are grooved on their outer periphery to hold a spring ring 2*a* for holding the pinions 2 on their pins. The gear train is completed by the annulus 5 meshing with the planet pinions 2. An extension of the gear ring 5*a* is provided internally with splines 5*b* and on its end with ratchet teeth 5*c*. The planet carrier 3 is also provided with an extension 3*c* in which are cut slots 3*d*. A ring 6 is mounted on the extension 3*c* so as to slide axially thereon by the influence of the spring 7 and internal dogs 6*a* constrain this ring 6 to rotate with the planet carrier 3. Ratchet teeth 6*b* are formed on one face of the ring and these engage with co-acting teeth 8*a* on the bearing member 8.

The bearing member 8 is screwed into the hub shell 9 at 9*a* and rotates on balls 10 running on a further bearing member 11 which is screwed on the axle 1. Into the other end of the hub shell at 9*b* is screwed a further bearing member 12 running on balls 13 which run on a race formed on the input member 14. The input member 14 runs on further balls 15 running on a further bearing member 16 which is screwed on the axle 1. Within the member 12 is a ring 17 free to rotate or move axially on the input member 14 and provided with dogs 17*a* which engage with splines 12*a* in the member 12 so that the ring 17 is constrained to rotate with the member 12. The ring 17 is further provided with ratchet teeth 17*b* which co-act with the teeth 5*c* on the annulus 5 under the influence of the spring 18. Mounted on the axle 1 is a sleeve 19 provided with a key 20 free to move axially in the axle slot 1*b*. A rod 21 is screwed into the axle key and lies in a hole 1*c* of the axle 1. Mounted on the sleeve 19 is a clutch member 22 and a washer 23 and spring 24 normally urges the clutch member 22 to the left unless the control rod 21 is moved by external means. The clutch member 22 has projecting limbs 22*a* engaging with slots 14*a* in input member 14 so that the clutch member 22 is constrained to rotate with the input member 14 but is able to slide axially therein. Mounted on the input member 14 is a sprocket 25 in splines 14*b* secured by washers 26 and a circlip 27.

The operation of the gear is as follows. Normally the spring 24 urges the clutch member to the left so as to couple the input member 14 to the planet carrier 3 by engagement of the

limbs 22*a* with the dog members 3*b*. Since in an epicyclic gear of this type the annulus is always the fastest rotating member the drive is transmitted through the gears to the annulus 5 and hence via the teeth 5*c* to the ring teeth 17*b*, the dogs 17*a* and splines 12*a* to the hub shell 9. Since the bearing member 8 is rotating faster than the planet carrier 3 the ratchet teeth 8*a* over-ride the ratchet teeth 6*b* on the ring 6 which rotates with the carrier 3. This gives an increase gear.

When the clutch member 22 is moved to the right by pulling the control rod 21 until the clutch member 22 engages the splines 5*b* on the annulus as shown below the centre line in Figure 1 a direct drive is obtained since the gear train is then only idling. The left hand ratchet teeth 8*a* and 6*b* over-run as described for the increase gear.

Further movement of the clutch member 22 to the right causes the right hand edges of the limbs 22*a* to move the ratchet ring 17 to the right so as to disengage the ratchet teeth 17*b* and 5*c* but still leaves the input member coupled to the annulus splines at 5*b* via the limbs 22*a*. The drive now enters the annulus and is transferred via the gears to the planet carrier and thence via the ratchet teeth 6*b* and 8*a* to the bearing member 8 and the hub shell 9. This gives a reduction gear. This gear position is shown above the centre line in Figure 1.

In the previously known construction it has been necessary to phase or position the pawls with the splines so that the limbs of the selector member can engage with and tip the pawl out of engagement with the splines. In the construction above described such phasing or positioning is not necessary and this represents an important simplification of construction.

In a modified construction of the gear, the output ratchet coupling illustrated at the left hand end of Figure 1 and consisting of the parts 3, 6 and 8 could be replaced by the normal radial pawl and ratchet coupling since there is usually ample space at this end for such type of ratchet coupling.

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PROVISIONAL SPECIFICATION
No. 14118 A.D. 1953

## Improvements in or relating to Epicyclic Change-Speed Gearing

We, STURMEY-ARCHER GEARS LIMITED, a British Company, of 177, Lenton Boulevard, Nottingham, in the County of Nottingham, do hereby declare this invention to be described in the following statement:—

This invention relates to epicyclic change-speed gears for pedal bicycles of the type comprising sun, planet, planet carrier and annulus members with alternative pawl and ratchet couplings respectively a first ratchet coupling between the annulus and an output member and the second ratchet coupling between the planet carrier and the output member, with a slidable selective coupling member adapted to couple an input member with either the planet carrier or the annulus in combination with means for rendering the first ratchet coupling inoperative for one position of the slidable selective coupling member while providing coupling between the input member and the annulus. Such hubs are well known. The epicyclic gear train may be of the simple type or may comprise stepped planet pinions which may be used with alternative sun wheels or may comprise two or more coupled gear trains. The feature common to these hubs is the alternative output couplings with provision for rendering the annulus ratchet coupling inoperative as above described.

For use on pedal bicycles it is desirable that the diameter of the hub shell should be kept as small as possible on the score of appearance and that the hub should be kept as light as possible consistent with the strength necessary to carry the loads imposed. The size and weight of such hubs is governed in the main by strength considerations and not by the diameter of the gear train as such. The input member must be of a size adequate to carry the input torque and this size in turn governs the size of the surrounding member which carries the output coupling pawls normal to such hubs.

The invention is a further development of the invention forming the subject of co-pending Application for Patent No. 28917/52.

It is one object of this invention to provide other forms of improved ratchet output coupling mechanism for hubs of this type which provides adequate strength in a smaller space than hitherto, with a consequent possible reduction in the size and weight of the hub.

It is a further object to provide other forms of a simpler method of rendering such ratchet coupling inoperative for the known purpose of using the other output coupling for any selective ratio thereby made available and which method avoids the need for phasing of the selector member and the output coupling.

According to the invention an epicyclic change-speed gear for pedal bicycles comprising sun, planet, planet carrier and annulus members with alternative pawl and ratchet couplings respectively a first ratchet coupling

between the annulus and an output member and a second ratchet coupling between the planet carrier and the output member with a slidable selective coupling member adapted to couple an input member with either the planet carrier or the annulus in combination with means for rendering the first ratchet coupling inoperative for one position of the slidable selective coupling member while providing coupling between the input member and the annulus is characterised in that the first ratchet coupling consists of a single coupling ring having separate sets of coupling formations directly complementary to coupling formations on the annulus and output members, one such set of coupling formations providing ratchet coupling, the ring being slidable to engage or disengage one of the sets of coupling formations.

A variable gear hub according to the invention may be further characterised in that the other of the sets of coupling formations remains operatively engaged while the one set is disengaged; or in that the single slidable coupling ring has ratchet teeth formations on one end face and dog-coupling formations on its outer periphery; or in that the single slidable coupling ring carries outwardly directed pawls and axially disengageable dog-clutch formations; or in that the axially disengageable dog-clutch formations are on one end face; or in that the single slidable coupling ring carries outwardly directed disengageable pawls and has constant mesh internal dog-clutch formations.

According to one embodiment of the invention, as described in the earlier Specification aforesaid, an epicyclic change speed gear of the type described for the rear wheel hub of a bicycle is characterised in that one set of coupling formations on the ring comprises ratchet teeth on one face of the ring engageable with complementary face teeth on the annulus, means normally urging the ring into coupling thereby with the annulus and in that the other set of coupling formations on said ring comprises dogs slidably and in all positions positively engaged with complementary formations on the output member.

According to other embodiments of the invention as described herebelow and forming the subject of the present invention, one set of coupling formations on the ring comprises radially operative ratchet pawls engageable with complementary inwardly directed ratchet teeth on the ring and the other set of coupling formations comprises dogs on the ring slidably engageable with complementary dogs on the annulus, sliding movement of the ring effecting disengagement of either the one or the other set of coupling formations.

Figs. 1, 2 and 3 are drawings illustrating the first embodiment of the invention which have been filed with the Specification accompanying the earlier application for Patent aforesaid.

In the accompanying drawings:—

Fig. 4 is a longitudinal section on line 4—4 of Fig. 5 of a three-speed hub made in accordance with the present invention some of the parts being shown in one gear position above the centre line and in another gear position below the centre line;

Fig. 5 is a section on line 5—5 of Fig. 4;

Fig. 6 is a section on line 6—6 of Fig. 4;

Fig. 7 is a fragmentary detail view of part of Fig. 4;

Fig. 8 is a longitudinal section similar to Fig. 4 on line 8—8 of Fig. 9 showing only the right-hand end of a further modified construction;

Fig. 9 is a cross section on line 9—9 of Fig. 8;

Fig. 10 is a fragmentary view of part of Fig. 8.

Where the parts are the same or substantially the same as described for Figs. 1 to 3, they are given the same reference characters.

As shown in Figs. 4 to 7, a change speed gear hub comprises a fixed axle 1 on which is cut a sun pinion 1*a*. Meshing with this sun pinion are planet pinons 2 which are carried on pins 3a of the planet carrier 3. Said planet carrier is rotatably mounted on a rebated flange 1*d*. The pins 3*a* are extended through the pinions 2 so as to form driving dog members and a ring 2*b* is mounted on the extended pins so as to position the planet pinions 2. The gear train is completed by the annulus 5. An extension of the annulus 5 is slotted to form inwardly directed dogs 5*d* and end dogs 5*e*. The planet carrier 3 is also provided with an extension 3*e* carrying pawls 3*f* which engage with ratchet teeth 8*a* formed in an end cap 8 which is screwed at 9*a* into the hub shell 9 which rotates on balls 10 on a bearing member 11 which is screwed to the axle 1 into the other end of the hub shell 9. At 9*b* is screwed a further end cap 12 mounted on ball bearings 13 which in turn run on an input member 14 which again is mounted on further balls 15 running on a bearing member 16 screwed on the axle 1. Within the end cap 12 and slidably and rotatably mounted on the input member 14 is a ring 17*c* carrying pawls 17*d* located in pockets 17*e*. The ring 17*c* is urged in one direction by a spring 18 engaging a washer 18*a* which washer also serves to retain the pawls 17*d* in their pockets. These pawls are adapted to engage ratchet teeth 12*a* formed on the end cap 12. Mounted on the axle 1 is a sleeve 19 provided with a key 20 free to move axially in a slot 1*b* a rod 21 is screwed into the axle key 20 and is located in an axial hole 1*c* in the axle 1. Mounted on the sleeve 19 is a clutch member 22 behind which is a washer 23 and spring 24 normally urging the clutch member 22 to the left of Fig. 4 against any restrain force applied through the rod 21. The clutch member 22 has peripheral dogs 22*a* projected through apertures between finger-

like extensions 14*a* of the input member 14 so that such clutch member is constrained to rotate therewith but is able to slide axially. The dogs 22*a* are adapted peripherally to engage the internally formed dogs 5*d*. Mounted on the input member 14 is a chain sprocket 25 located on splines 14*b* and secured by washers 26 and a spring ring 27. The ring 17*c* is formed with an annular recess providing an end face 17*f* adapted to be engaged by the end face of the dogs 22*a* and such ring 17*c* is formed with end dogs 17*g*. The operation of the gear is as follows:—

The spring 24 urges the clutch member 22 to the left of Fig. 4 so as to couple the input member 14 to the planet carrier 3 by engagement of the dogs 22*a* with the pinion pins 3*a* as shown dotted in the lower half of Fig. 4. At the same time the spring 18 urges the ring 17 so that the end dogs 17*g* are fully engaged with the end dogs 5*e*, such position being shown in the upper half of Fig. 4. Since in an epicyclic gear of this type the annulus is always the fastest rotating member, the drive, transmitted through the gears to the annulus 5 passes via the end dogs 5*e* and 17*g* to the ring 17 and then through the pawl 17*d* to the ratchet teeth 12*a* and so to the hub shell 9. Since the end cap 8 is rotating faster than the carrier 3 the ratchet teeth 8*a* overrun the pawls 3*f*. This gives an increase gear.

When the clutch member 22 is moved to the right by the rod 21 until the lugs 22*a* engage with the inner dogs 5*d* of the annulus 5 as shown below the centre line of Fig. 4 a direct drive is obtained since the gear train is only idling, the drive passing direct through the coupling 22*a* and 5*d* to the annulus and through the pawls 17*d* and ratchet teeth 12*a* to the end cap 12.

Further movement of the clutch member 22 to the right causes the right hand faces of the peripheral dogs 22*a* engaging the end face 17*f* to move the ring 17*c* to the right so as to disengage the end dogs 17*g* and 5*c* but still leaves the coupling between 22*a* and 5*d*. The drive still entering the annulus through such coupling is transferred via the gears to the planet carrier 3 and thence via the pawls 6*c* and ratchet teeth 8*a* to the end cap 8 and hub shell 9. This gives a reduction gear and the positions of the parts are as shown above the centre line in Fig. 4. The pawls 17*d* remain engaged with the ratchet teeth 12*a* and the ring 17*c* being otherwise free can therefore rotate with the end cap 12.

A further modification of the invention is as shown in Figs. 8 to 10. The arrangement of the parts is generally as shown in Figs. 4 to 7 but with the following variations. A pawl ring 28 is provided replacing the ring 17*c* and having lugs 28*a* (see Fig. 9) engaging with slots between dog-like extensions 29*a* in the annulus 29 so that it always rotates with the annulus but is capable of moving axially therein. In the lugs 28*a* are pawl housings 28*b* carrying pawls 30 engageable with short ratchet teeth 31*a* in the end cap 31. The gear movements are as before, direct drive being shown below the centre line and the reduction gear above the centre line. It will be seen that the clutch member has now moved the ring 28 so as to disengage the pawls 30 axially from the teeth 31*a* and so break the driving connection between the annulus 29 and the output member 31. The left-hand position of the ring 28 under the action of the spring 18 is determined by a shoulder 29*b*. Such position is shown in the lower half of Fig. 8.

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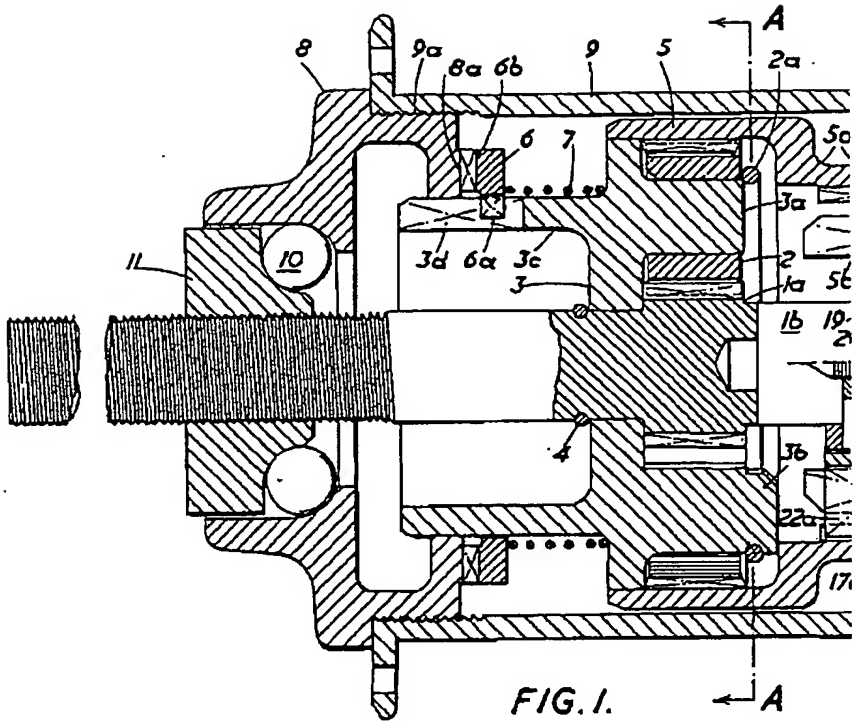
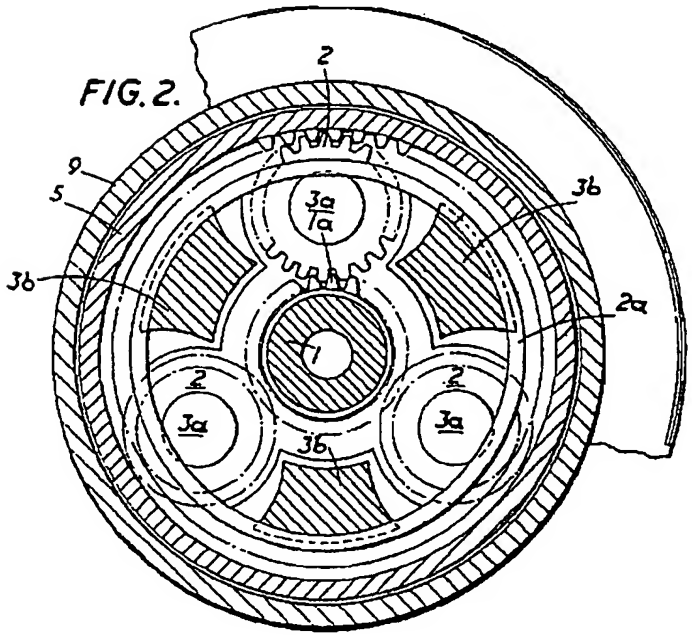

A
8
9a
8a
6b
9
5
2a
6
7
5a
3a
3d
6a
3c
2
11
10
3
1a
5b
1b
4
3b
22a
A

FIG. 1.

FIG. 2.


2
9
5
3a
1a
3b
3b
2a
1
2
2
3a
3a
3b

749,248 PROVISIONAL SPECIFICATION № 28,917/52

1 SHEET

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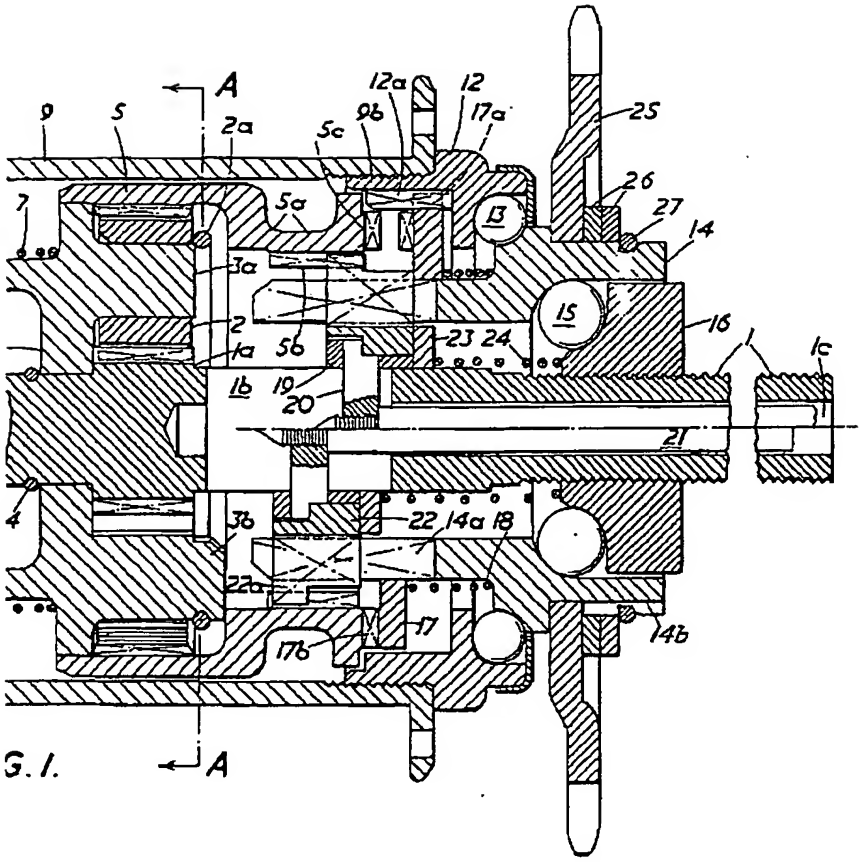
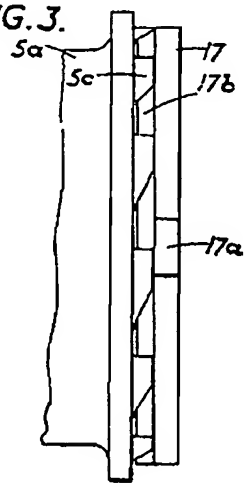



G. 1.


FIG. 3.



749,248 PROVISIONAL SPECIFICATION No 28.917/32

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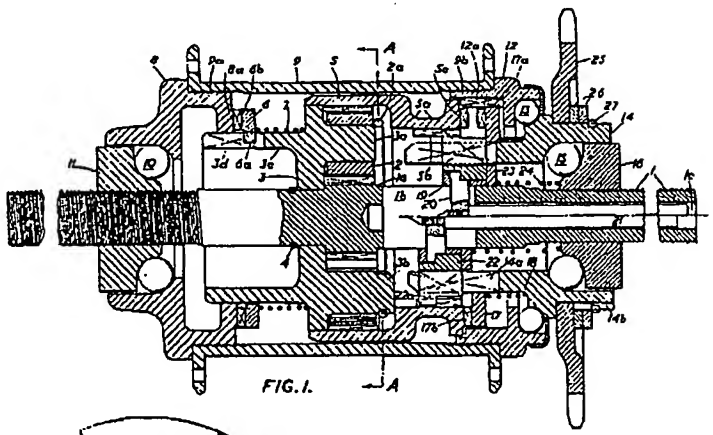
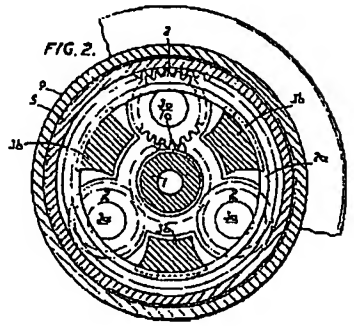


FIG. 1.



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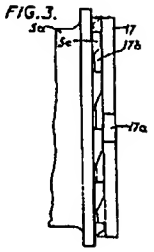
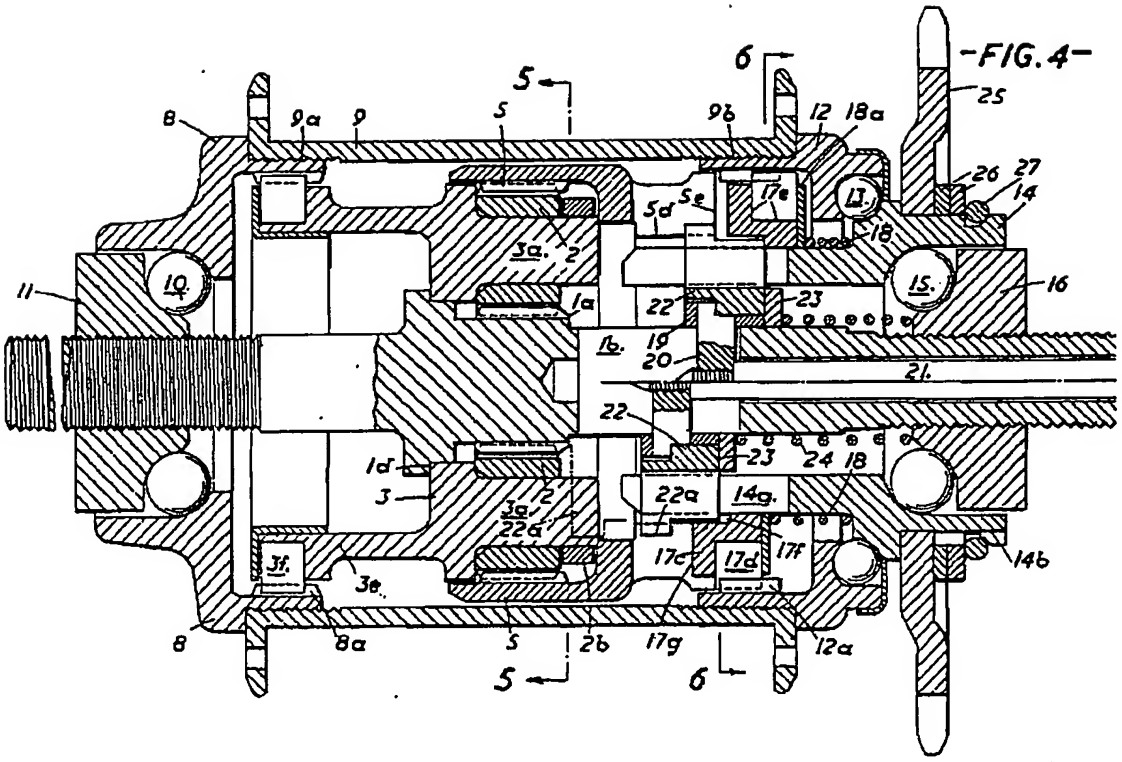


FIG. 3.


-FIG. 4-
6
5
8
9a
9
5
9b
12
18a
25
26
27
14
17e
13
5d
5e
18
3a
2
10
11
1a
22
23
15
16
1b
19
20
21
22
23
24
18
1d
3
12
3a
22a
22a
14g
14b
3f
3e
17c
17d
17f
8
8a
5
2b
17g
12a
5
6

749,248 PROVISIONAL SPECIFICATION Nº 14,118/53

2 SHEETS

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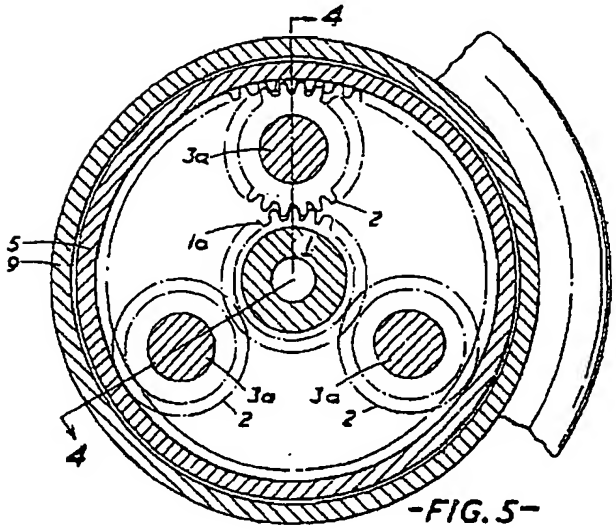
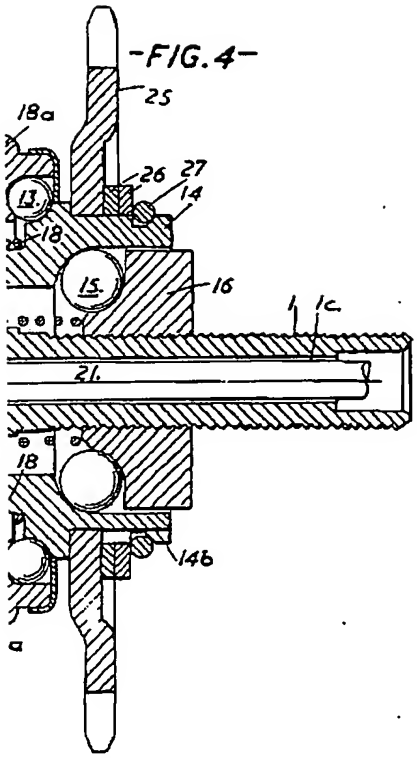
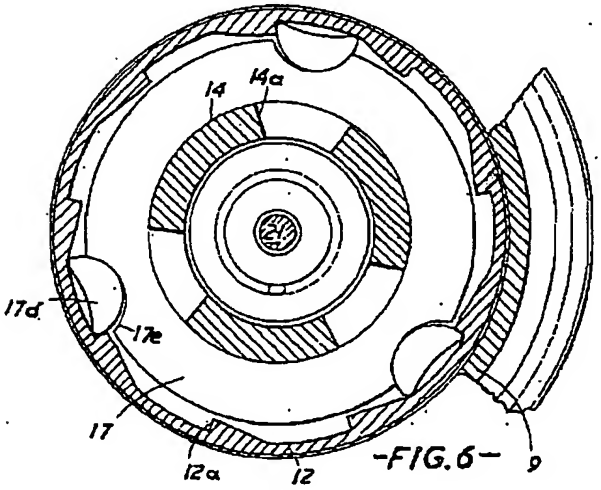
SHEET 1



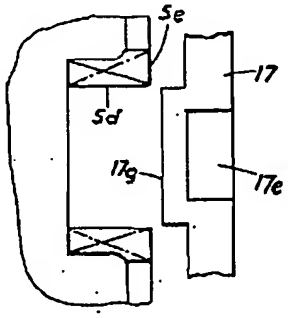

-FIG. 5-




-FIG. 4-




-FIG. 6-




-FIG. 7-

749,248 PROVISIONAL SPECIFICATION No 14,118/53

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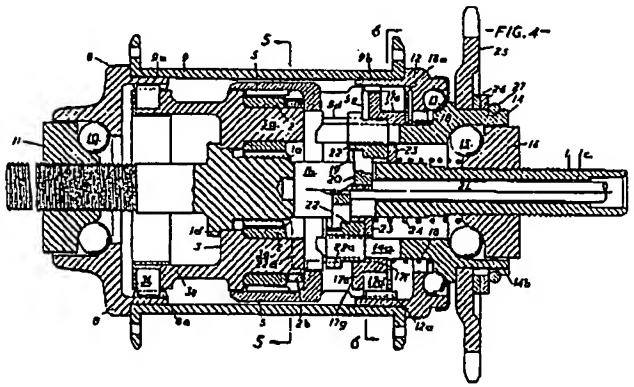
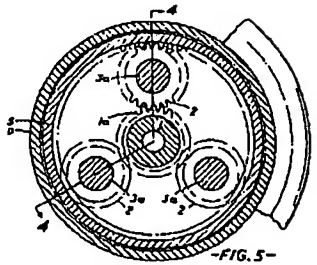
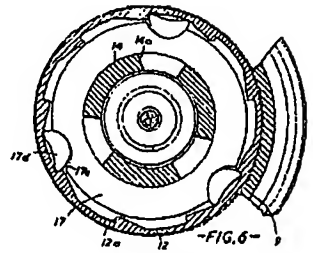


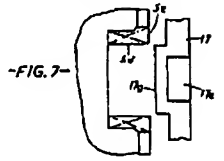
-FIG. 4-



-FIG. 5-



-FIG. 6-



-FIG. 7-

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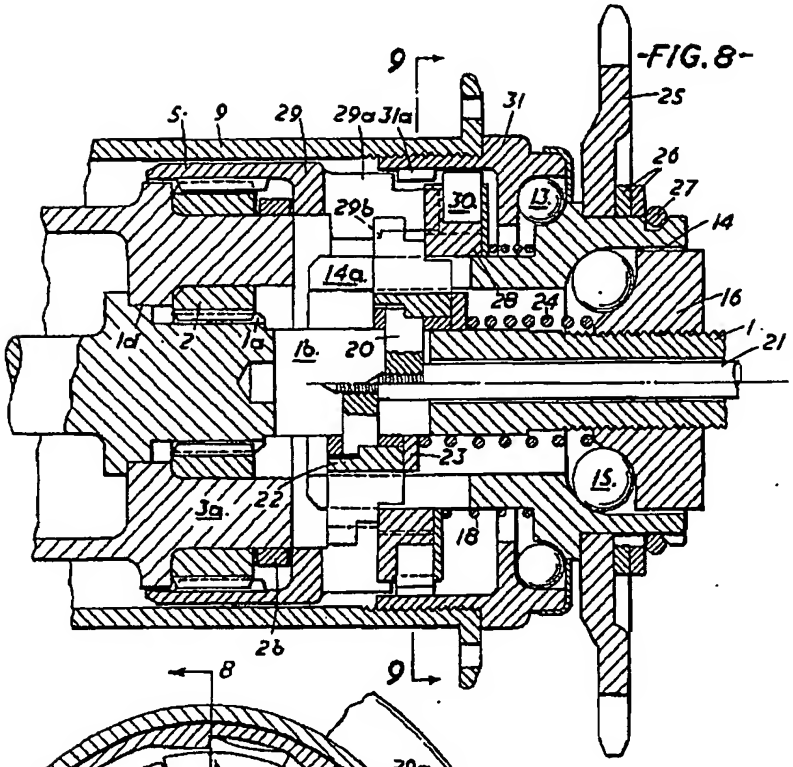
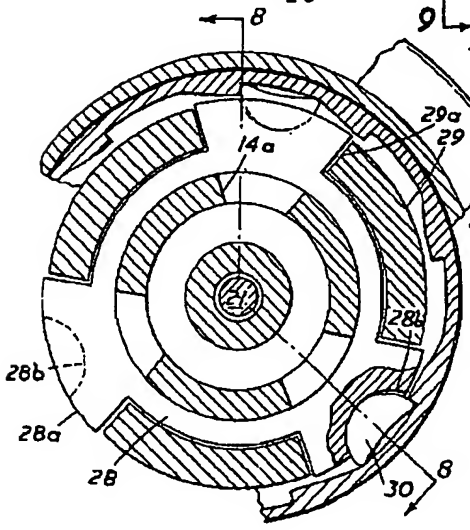
SHEET 2

-FIG. 8-




-FIG. 9-




-FIG. 10-